INFLUENCE OF CANOLA OIL, SELENIUM AND VITAMIN E ON CHOLESTEROL METABOLISM IN FEEDLOT CATTLE

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Abstract – Beef is a nourishing food that is frequently related to the cardiovascular illnesses due to its fat acids ratio and cholesterol levels. However, some studies have demonstrated a synergic effect between selenium and vitamin E on lipid metabolism. On this way, the objective of this study was to determine the effect of canola oil, selenium and vitamin E on cholesterol metabolism in beef cattle. Forty eight Nellore bovines were divided into four groups, as follows: 1) Control (C): Basal diet; 2) Antioxidants (CA): Control diet plus 2.5mg Se/kg of dry matter (DM) and 500UI of vitamin E/kg DM; 3) Oil (CO): Control diet plus 3% of canola oil/kg DM; 4) Oil + Antioxidants (CAO): Control diet plus 2.5mg of Se/kg DM, as organic selenium, 500UI of vitamin E and 3% of canola oil/kg DM. There was increase in serum cholesterol during the time. At 28, 56 and 84 days, CO treatment presented higher cholesterol concentration compared to other treatments. The selenium supplementation resulted in a lower cholesterol concentration in meat, higher oxidized glutathione (GSSG); lower reduced glutathione (GSH) and GSH/GSSG in Nellore liver compared to control. The production of meat with lower cholesterol would benefit both marketing and public health.

Key Words – Antioxidant, Lipids, Minerals

I. INTRODUCTION

Beef contains important nutrients for human health and nutrition. Nevertheless, the fat is often associated with increased blood cholesterol, cardiovascular disease and atherosclerosis, due to the saturated fatty acids proportion and the cholesterol content. Some experiments have demonstrated a synergistic effect between selenium and vitamin E on lipid metabolism.

Selenium and Vitamin E act together on balancing the oxidized and reduced glutathione (GSH and GSSG, respectively), and being part of glutathione peroxidase (GPx) may associate the selenium and vitamin E with the cholesterol metabolism. The reason may be the GSH/ GSSG ratio, and the consequent alteration of HMG-CoA reductase activity (3-hydroxy-3metil-glutaryl-CoA) [1], enzyme that is primarily responsible for controlling of cholesterol synthesis [2].

Therefore, the decrease of cholesterol in meat for human consumption would be beneficial for both marketing and public health, since the meat is a important food due to their excellent nutritional value.

On this way, the objective of this study was determine the effect of canola oil use as fat source, and the antioxidant effects of selenium and vitamin E, on cholesterol metabolism in feedlot cattle.

II. MATERIALS AND METHODS

A. Local

The experiment was conducted in the Faculty of Animal Science and Food Engineering of University of São Paulo (FZEA/USP), Pirassununga *Campus*, State of São Paulo, Brazil, for a period of 84 days.

B. Animals

Forty eight Nellore bulls with approximately 2 years-old, in the finishing phase, were used. The animals were placed in Calan Gate feed system, with individual feeding.

C. Treatments

On arrival, the animals went through a period of adaptation (28 days) to the diet and to the feed system and then were divided into four groups, as described: 1) Control (C): Basal diet without supplementation; 2) Antioxidants (CA): Control diet with 2.5mg Se/kg of dry matter (DM) and 500UI of vitamin E/kg DM; 3) Oil (CO): Control diet with 3% of canola oil/kg DM; 4) Oil + Antioxidants (CAO): Control diet with 2.5mg of Se/kg DM (as organic selenium), 500UI of vitamin E and 3% of canola oil/kg DM. All animals received diet containing 30% corn silage and 70% concentrate. Diets were formulated to meet the nutrient requirements recommended by the NRC [3].

D. Experimental procedure

Four blood samples were taken from each animal at week baseline before the start of the experiment (0) and then at weeks 4, 8 and 12, for analyses of total cholesterol.

The slaughter was performed following humanity standard procedures at a local slaughterhouse. The captive bolt method was used to stun the animals. Carcasses were split, weighed and then chilled at 0-3ºC before processing on the following day after slaughter. At 24 hours *post-mortem*, *Longissimus dorsi* muscle (13th through the 10th rib) from right carcasses were removed and cut into 2.5 cm thick steaks. Samples of 5g (triplicate) were collected and immediately frozen using liquid Nitrogen (N_2) for posterior cholesterol analysis.

E. Analytical Procedures

Analyses of cholesterol in serum were performed in a specialized laboratory, using enzymatic kits.

Analyses of muscle cholesterol were conducted at Laboratory of Biochemistry (FZEA/USP), according to the methodology described by Saldanha et al. [4].

F. Statistical Analysis

Statistical analyses of serum cholesterol were performed by ANOVA for repeated measures within a completely randomized design, using the PROC MIXED procedure of SAS [5]. For cholesterol in meat, GSH and GSSG in liver, PROC GLM was used, at 5% significance.

III. RESULTS AND DISCUSSION

The mean concentrations of total cholesterol in bovine serum as a function of treatment and time are shown in Table 1.

Cholesterol concentrations in *L. dorsi* muscle in function of the treatments are presented in Figure 1.

Table 1 Cholesterol (mg/dL) in serum of Nellore bulls in feedlot

Treatments	Time (Days) 0	28	56	84	SE
C	116.75^{cA}	143.67^{bC}	160.58^{bC}	183.50^{aBC}	4.18
CO	132.58^{cA}	183.83^{bA}	205.50^{aA}	217.50^{aA}	6.38
CA	125.00^{cA}	138.92^{bcC}	152.58^{abC}	168.33^{aC}	3.67
CAO	130.50^{cA}	164.58^{bB}	186.50^{aB}	194.25^{aB}	4.69

	P value
Treatment	<0.001
Time	<0.001
Treatment*Time	0.0533

C: control; CO: control+oil; CA: control+antioxidants; CAO: control+oil+antioxidants.
SE = Standard error.

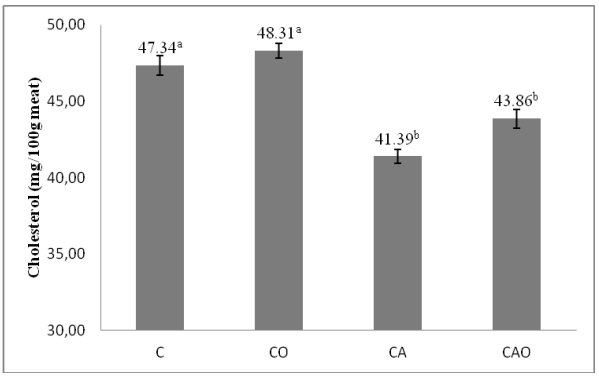

Figure 1 Cholesterol concentrations in *L. dorsi* muscle of Nellore bulls receiving different diets.
C: control; CO: control+oil; CA: control+antioxidants; CAO: control+oil+antioxidants.

There were significant effects (p<0.001) of treatment on serum and *L. dorsi* cholesterol of Nellore cattle. For serum, time has also influenced, increasing cholesterol concentration during the period. At 28, 56 and 84 days, CO treatment presented higher cholesterol concentration

compared to treatments with antioxidants (CA, CAO) and control.

Considering cholesterol in muscle, treatments with selenium and vitamin E (CA and CAO) supplementation presented lower concentration compared to control and canola oil (CO). There was no difference between CAO and CA treatments and between control and CO.

The GSH and GSSG mean concentrations (μmol/g liver) and the GSH/GSSG ratio in the liver of cattle, as a function of the different treatments are presented in Table 2.

GSH/GSSG and GSH values were lower ($P<0.001$) for animals supplemented with selenium and vitamin E compared to those that received control and canola oil diets. Animals receiving treatments CA and CAO had higher GSSG concentrations in the liver than those who received other treatments. For these parameters, there was no significant difference ($P>0.05$) between C and CO and between CA and CAO.

Table 2 GSH and GSSG concentrations (μmol/g) and the GSH/GSSG ratio in the liver of Nellore bulls in feedlot

	Treatments				SE
	C	CO	CA	CAO	
GSH	1.82[a]	1.74[a]	1.23[b]	1.18[b]	0.07
GSSG	0.004[b]	0.004[b]	0.007[a]	0.007[a]	0.00
GSH/GSSG	566.93[a]	503.45[a]	191.05[b]	166.42[b]	35.68

C: control; CO: control+oil; CA: control+antioxidants; CAO: control+oil+antioxidants.
SE = Standard error.
In a row, values followed by the same letter do not differ ($p>0.05$).

Del Claro [6], in an experiment with Brangus, reported no significant difference ($p>0.05$) in serum cholesterol concentration and in GSH concentration in liver for animals supplemented with selenium or receiving the control diet, conflicting with the present experiment. However, the same author found a decreased ($p<0.05$) in cholesterol concentration in muscle, increased of GSSG values and reduced GSH/GSSG ratio in the liver of cattle supplemented with 2 mg/kg of selenium, results that agree with the ones obtained in this study.

Studies have shown that thiol/disulfide ratio of cells can influence the activity of several key enzymes that require thiol groups for activity [7,8]. One of these is HMG-CoA reductase, which activity is considered the step for controlling the cholesterol synthesis [9, 2]. In vitro studies showed that this enzyme requires thiols for its activity and GSH is the major one [10]. Besides, small concentrations of disulfides, such as GSSG, decrease the activity of the enzyme [8].

According to Kim et al. [1], cholesterol biosynthesis can be regulated by GSH decreasing and GSSG increasing. The GSH would stimulate the production of HMG-CoA, involved in organic synthesis of cholesterol. The decrease of intracellular GSH can occur through protecting liver cells from the toxic effects of free radicals, depending on the GSH-Px activity reducing GSH to GSSG. It is suggested that inhibition of GSH by a specific inhibitor should cause lower HMG-CoA reductase activity, decreasing cholesterol synthesis [1].

In the present experiment there was a reduction in the GSH concentration and GSH/GSSG ratio, and an increase in the GSSG concentration with selenium supplementation. Therefore, the activity of the HMG-CoA reductase enzyme might have decreased. The activity of this enzyme was not measured; however, the relationship cited in discussion can explain the results of reduction of cholesterol levels in muscle *L. dorsi* in treatments using selenium.

IV. CONCLUSION

There was influence of selenium supplementation on cholesterol metabolism in Nellore beef, with reduced concentration in *L. dorsi* muscle. The production of meat with lower cholesterol would benefit both marketing and public health.

ACKNOWLEDGEMENTS

Authors thank to FAPESP (Grant 2010/20689-5) for the financial support.

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